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Asterinid seastars (Echinodermata: Asteroidea) from the Gulf of Oman, Iran

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Field surveys in the rocky south-east coast of Iran and northern part of the Gulf of Oman were conducted during a period from October 2014 to March 2015. The Asterinid seastars *Patiriella paradoxa* (Campbell and Rowe), *Aquilonastra watersi* (O'Loughlin and Rowe) and *Aquilonastra iranica* (Mortensen) are reported for the first time from the Iranian coast. The morphological taxonomy and the ecology of these asteroids are discussed in this work.

[Keywords: First record; *Patiriella paradoxa*; *Aquilonastra iranica*; Aquilonastra watersi; Chabahar Bay]

Introduction

Chabahar Bay is located in the south-east of Iran at the junction of the Oman Gulf and Arabian Sea. Echinoderm fauna of the south-east coast of Iran is not fully known. However, echinoderms species from this region have been reported[1,2,3,4,5]. In the present study, *Patiriella paradoxa* (Campbell and Rowe 1997), *Aquilonastra watersi* (O'Loughlin and Rowe 2006) and *Aquilonastra iranica* (Mortensen, 1940) are documented as new records for Chabahar Bay (Oman Gulf) in the sub-tidal and inter-tidal zones. The present study details and discusses the morphological taxonomy and ecology of these asteroids.

Materials and Methods

During monthly field surveys from October 2014 to March 2015, echinoderm seastars were collected by diving in the rocky shallows (7 m) at Konarak, in the northern Gulf of Oman on the Iranian eastern of Chabahar Bay (25˚18'2.51˚N: 60˚25'43.68˚E). The echinoderm seastars were also collected by hand from the rocky inter-tidal area at Tis Port on the western coast of Chabahar Bay (25˚21.1'N 60˚36.0'E) (Fig. 1). Seastars were collected in the sampling bags containing seawater and transferred to the laboratory for identification. Photographs of live specimens were taken with camera model Canon PowerShot D10. Specimens were then fixed in 4% buffered formalin and transferred to 75% alcohol for identification. Specimens were examined under the stereomicroscope coupled with a camera model C–DS model T4AL250V (21V150W). The samples were cleared of surface spines and spinelets using commercial bleach. Specimen were identified by morphological diagnostic characters[6,7,8,9,10,11] and then deposited in the Marine Science Laboratory at Chabahar Maritime University.

Results

From the field survey, three species belonging to family Asterinidae were identified. All three species are reported for the first time in the Chabahar Bay (Oman Gulf) in the sub-tidal and inter-tidal zones.

Systematics

Phylum: Echinodermata
Class: Asteroidea
Suborder: Valvatacea
Order: Valvatida
Family: Asterinidae Gray, 1840
Genus: *Patiriella* Verrill, 1913
Species: *Patiriella paradoxa* Campbell and Rowe, 1997
(Figures 2A-F)

Material examined-Patiriella paradoxa

The presently reported specimens of *Patiriella paradoxa* were collected by diving in the rocky shallows area at Konarak located on the eastern coast of Chabahar Bay; coordinates: 25˚18'2.51˚N 60˚25'43.68˚E; water depth: 7 m; 5 specimens; 20 October 2014.

Description: R: 20 mm, r: 11 mm, R/r: 1.81; form stellate and rays with ends broadly rounded, rays tapering from a relatively wide base to a rounded tip, sides steep; rays 5 (rarely 4–6) (Figs 2A and B); noticeable integument; orally flat, abactinally arched;

lacking pedicellariae; gonopores abactinal; single conspicuous madreporite surrounded by spinletes (Fig. 2C); abactinal plates imbricating and form two fields along the rays, abactinal plates on upper rays in irregular series, regular longitudinal series of crescent form plates on lower sides of rays; most abactinal plates X-shaped, some carinal plates Y-shaped; papulate areas more extensive than non-papulate areas on abactinal surface; papulate areas are relatively large, 3–6 large papulae and a few secondary plates per space (Fig. 2D); proximal primary abactinal plates irregular; glassy convexities below elevations on primary plates; glassy convexities below elevations on denuded plates, except on their proximal side; abactinal spinelets granuliform; crescentic ridge carries 4–5 spinelets in a single series. Superomarginal and inferomarginal plates in regular series, with typical abactinal spinelets; supermarginals higher than inferomarginals. Actinal inter-radial spines thick columnar (Fig. 2E). Actinal plates in oblique series; no suboral spines. Actinal spines per plate up to: oral: 6; furrow: 2; subambulacral: 1, tall; adradial: 0–1, short, incomplete series; actinal inter-radial 1 proximally, 2 short distally; (Fig. 2F). Superambulacral and superactinal plates present.

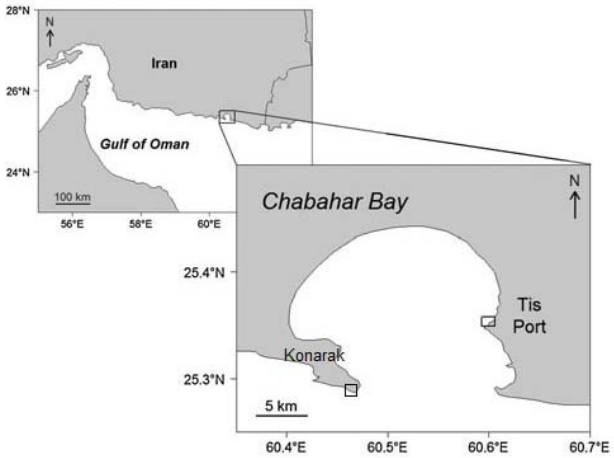

Fig. 1 — Study area locations in Chabahar Bay at the southern Iranian coast (Gulf of Oman).

Colour (live) is dark green, but on disc and upper rays it is black (Fig. 2A).

Distribution: Originally reported at Dhofar in southern Oman[7]. This is the first record of *Patiriella paradoxa* for the coast of Iran, at a depth of 7 m on the rocky substrate at Konarak, located in the east of Chabahar Bay.

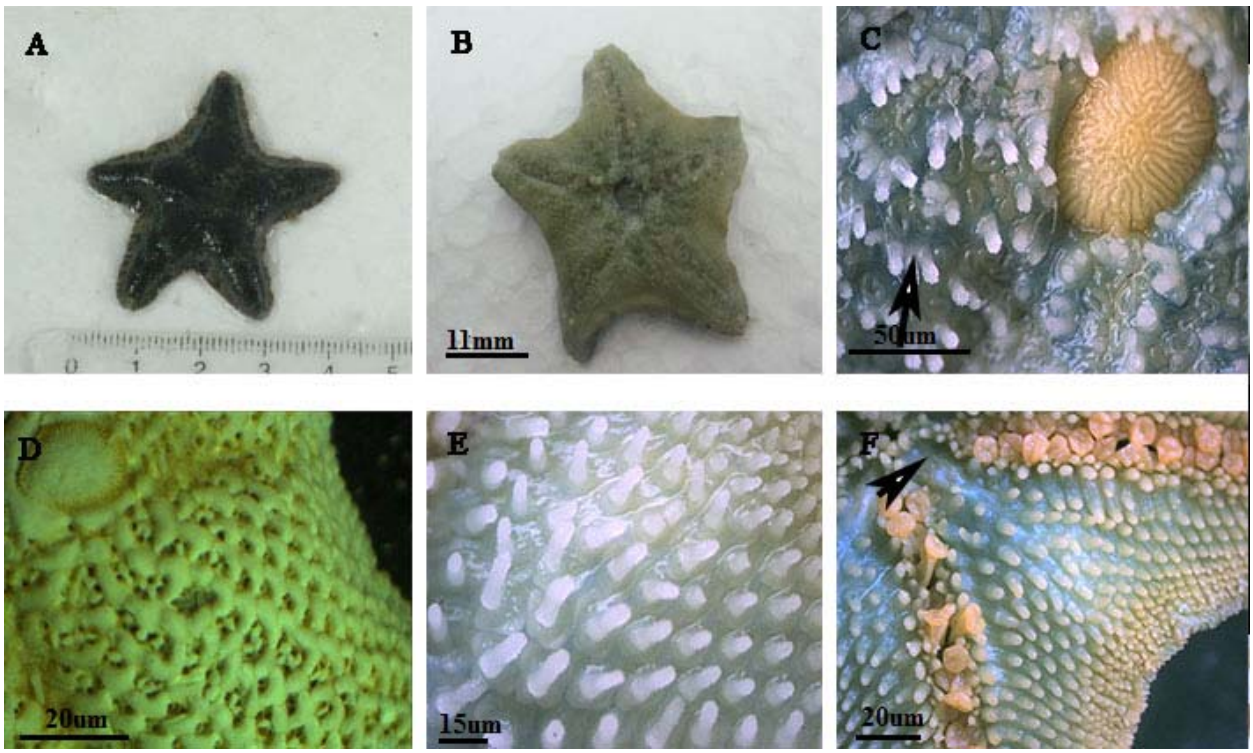

Fig. 2 — *Patiriella paradoxa* Campbell and Rowe 1997: (A) abactinal surface (live specimen *in vitro*); (B) actinal surface (live specimen *in vitro*); (C) maderporite and abactinal spinelets (arrow) (partly cleared); (D) papulae (left arrow) and secondary plates (right arrow) (dry specimen); (E) actinal interradius spines (partly cleared); (F) actinal ambulacra and interradius, lacking suboral spines (arrow) (preserved specimen).

Remarks: The present study specimens are similar to *Patiriella paradoxa* in the following characters: Absence of suboral spines; number of secondary plates and papulae per space; adradial actinal plates; form of abactinal spinelets. According to Campbell and Rowe[7], the type specimen measured R: 17.8 mm, r: 9.0 mm and R/r: 1.98, with abactinal spinelets per plate variably 5–7, but with no record of live colour. In the present study, the examined specimen measured R: 20 mm, r: 11 mm and R/r: 1.81, with abactinal spinelets per plate variably 4–5 and colour dark green with the centre of the disc black. Based on morphological characters, *P. paradoxa* is congeneric with *P. regularis*[7]. The main characters distinguishing *P. paradoxa* from the other species of *Patiriella* are the absence of suboral spines and few secondary plates and numbers of papulae per space. The diagnostic characters differences between *Patiriella* species are listed in Table 1.

Systematics:

Genus: *Aquilonastra* O'Loughlin in O'Loughlin and Waters, 2004

Species: *Aquilonastra watersi* O'Loughlin and Rowe, 2006
(Figs 3A-F)

Material examined - Aquilonastra watersi

The presently reported specimens of *Aquilonastra watersi* were found in the inter-tidal zone at Tis Port, located in the western part of Chabahar Bay; coordinates: 25˚21.1'N 60˚36.0'E; sandy-rocky substrate; 3 specimens; 2 March 2015.

Description: R: 28 mm, r: 13 mm, R/r: 2.15 mm, five unequal discrete rays, subdigitiform, inter-radial margin deeply incurved, rays tapering, narrowly rounded distally, orally flat, abactinally arched (Figs 3A and C); abactinal inter-radii have few pedicellariae (Fig. 3E); gonopores abactinal; single maderporite, glassy convexities on plates; abactinal spinelets each with up to four tufts each with 5–12 splayed spinelets (Fig. 3D), few secondary plates (Fig. 3F); spinelets glassy conical, splaypointed, in splayed clusters on plates; superomarginal plates smaller than inferomarginals; both in regular series. Up to 10 proximal doubly populate carinal plates, papular spaces, small, 2–3 papulae per space. Actinal: plates in longitudinal series; complete series of adradial actinal plates and spines. Actinal spines per plate up to: Oral: 12, suboral: 10, furrow: 6, subambulacral: 5 (Fig. 3G); actinal interradial 5–14 proximally, 7 distally; actinal inter-radial spines thick digitiform to conical. Up to about 16 spinelets on both superomarginal and inferomarginal plates, thicker on inferomarginals. Superambulacral and superactinal plates present. Colour of disc and proximal apical area: Madreporite orange, proximal rays and interradii mottled with dark and light red and white, disc and upper rays mottled red (Figs 3A and B).

Distribution: Arabian Sea, Oman; Red Sea, Egypt; Western Indian Ocean, Mauritius[11]. This is the first

Table 1 — Comparison of diagnostic distinctions of *Patiriella paradoxa* with *Patiriella* species.

	Diagnostic characters	[a] *P. paradoxa*	[b] *P. paradoxa*[7]	[c] *P. inornata*[7]	[d] *P. oliveri*[6]	[e] *P. irregular*[8]
1	Live colour	dark green	not recorded	not recorded	abactinal spines blue, underlying plates orange (dried)	predominantly olive–green
2	Form of arms	broad, tapering, rounded tip	broad, tapering, rounded tip	tapering, rounded tip	short, tapering, pointed	broad, tapering, rounded tip
3	Form of abactinal spinelets	granuliform	granuliform	subglobose	short, capitate	slender, digitate, tapering
4	Abactinal spinelets per plate	single row, variably 4–5	single row, variably 5–7	–	double row, up to 20	variably 10–30
5	Secondary plates and papulae	3–6 per space	3–6 per space	numerous per space, twelve or more	single papular pore	up to 13 per space
6	Carinal series	irregular	irregular	irregular	regular	irregular
7	Mid-actinal interradial spines	thick columnar, 1 per plate	thick columnar, 1 per plate	short conical, 1–3 (usually one) per plate	slightly swollen, 1 per plate	1 per plate
8	Proximal furrow spines	2 commonly	2 commonly	2–3 very short spinelets	2 commonly	2 commonly
9	Adradial actinal plate spines	incomplete series	incomplete series	complete series	complete series	0–1, incomplete series
10	suboral spine	absent	absent	present	present	present

record of *Aquilonastra watersi* (O'Loughlin and Rowe 2006) for the coast of Iran, and for first time it was found in the inter-tidal zone on the sandy-rocky substrate at Tis Port located in the western part of Chabahar Bay.

Remarks: The present study specimens are similar to *A. watersi* in the following characters: Form of rays; form of abactinal spinelets; few secondary plates and papulae per space and few pedicellariae. The specimens found in the present study measured R: 28 mm and colour live of proximal rays and inter-radii mottled with dark and light red and white, disc and upper rays mottled red; number spines per plate, oral: 12, suboral: 10, subambulacral: 5 in number spines per plate. O'Loughlin and Rowe reported size *A. watersi* up to with R: 16 mm[11]; colour live mottled pale brown, red-brown, gray-brown, blue-gray, off-white; and up to: oral 7, suboral 6, subambulacral 6 spines per plate.

The distinguishing characters of *A. watersi* are the thick pedicellariae and thin, long, subacicular abactinal spinelets. *A. watersi* is similar to *A. batheri* (Goto, 1914), but distinguished from it by the presence of few inter-radial pedicellariae and grouping of spinelets into tufts on proximal abactinal plates.

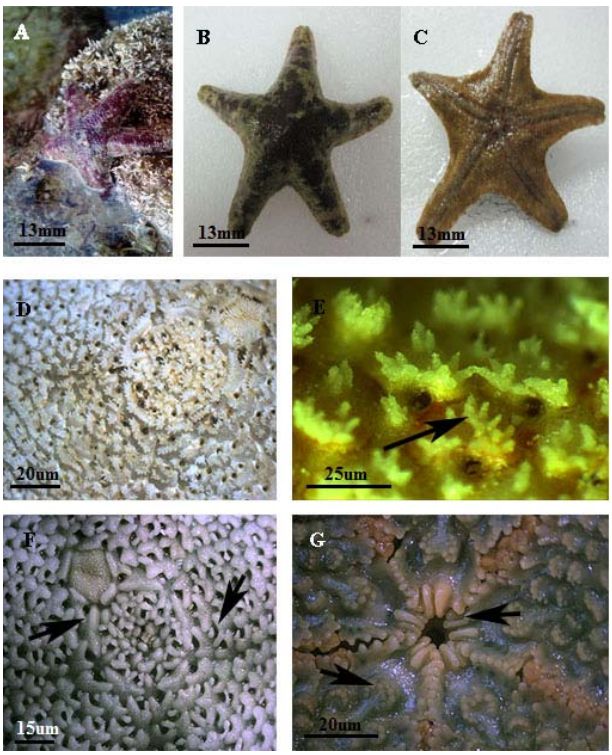

Fig. 3 — *Aquilonastra watersi* O'Loughlin and Rowe 2006: (A) Live specimen *in situ*; (B) abactinal surface (live specimen *in vitro*); (C) actinal surface (live specimen *in vitro*); (D) maderporite and abactinal spinelets (dryspecimen); (E) pedicellariae (arrow), and abactinal spinelets; (F) papulae (left arrows), and secondary plates (right arrow) (extensively cleared); (G) oral spines (right arrow), with suboral spines (left arrows) (preservedspecimen).

Systematics:

Genus: *Aquilonastra* O'Loughlin in O'Loughlin and Waters, 2004

Species: *Aquilonastra iranica* Mortensen, 1940

(Figs 4A-F)

Material examined-Aquilonastra iranica

The presently reported specimens of *Aquilonastra iranica* were found in the inter-tidal zone at Tis Port, located in the western part of Chabahar Bay; coordinates: 25˚21.1'N 60˚36.0'E; sandy-rocky substrate; 7 specimens; 2 March 2015.

Description: R: 26 mm, r: 15 mm, R/r: 1.73; five discrete rays, form substellate and rays tapering from a relatively wide base to a rounded tip (Figs 4A and C); sides steep, noticeable integument; orally flat, abactinally arched; pedicellariae sparse; gonopores abactinal; single conspicuous madreporite that is surrounded by carinal spinelets; abactinal spinelets conical and glassy, in small groups on abactinal

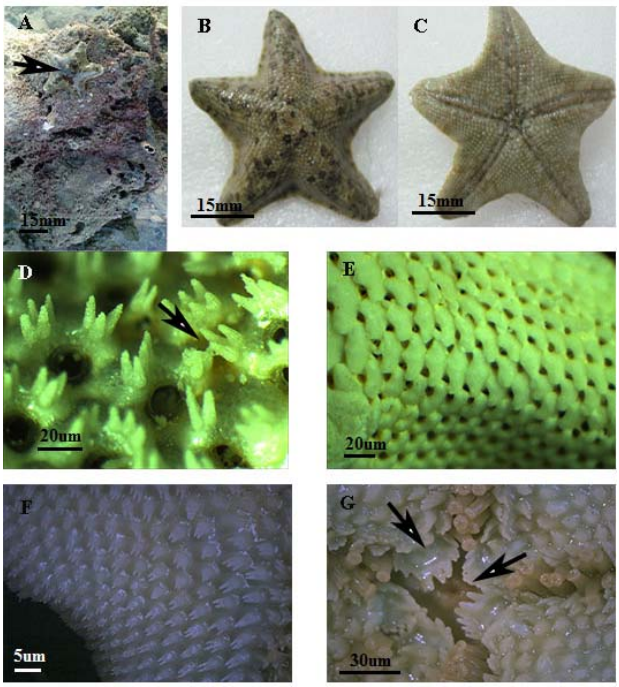

Fig. 4 — *Aquilonastra iranica* (Mortensen 1940): (A) Live specimen *in situ*; (B)abactinal surface (live specimen *in vitro*); (C) actinal surface (live specimen *in vitro*); (D) pedicellariae (arrow), and abactinal spinelets (dry specimen); (E) carinal plates (dry specimen); (F) actinal interradius plates (partly cleared); (G) oral spines (right arrow), with suboral spines (left arrows) (preserved specimen).

plates, up to 5 per group (Fig. 4D); carinal plates in regular series (Fig. 4E); papular areas with 1–2 large papulae, and lacking secondary plates; proximal primary abactinal plates regular; glassy convexities below elevations on denuded plates; superomarginal and inferomarginal plates in regular series, with typical abactinal spinelets; superomarginal smaller than inferomarginal plates. Actinal plates in longitudinal series; actinal spines per plate up to: Oral: 12, suboral: 10, furrow: 6, subambulacral: 5; actinal interradial 2–3, conical (Figs 4F and G).

Colour (live) is grayish, with reddish or bluish-gray spots (Figures 4A and B).

Distribution: Persian Gulf[11,12], Arabian Sea[11], Western Pakistan[11]. This is the first report of *Aquilonastra iranica* for Chabahar Bay and found in an inter-tidal zone on the sandy–rocky substrate at Tis Port located in the western part of Chabahar Bay.

Remarks: The present study specimens are similar to *A. iranica* in the following characters: Form of spinelets and spines, number of oral spines, and having pedicellariae sparse. The specimens found in the present study have number of spines per plate up to: Oral: 12, suboral: 10, furrow: 6, subambulacral: 5. O'Loughlin and Rowe reported the number of spines per plate for *A. iranica* up to: Oral 8, suboral 5, furrow 7, subambulacral 9[11]. Mortensen reported colour live for *A. iranica* to be grayish, with reddish or bluish-gray spots, as was found in the present study[12].

A. iranica is distinguished by its large size and the presence of pedicellariae[11]; few short and thick conical spinelets on proximal abactinal plates; abactinal spinelets conical and glassy, in small groups on abactinal plates; a large and conspicuous maderporite. Mortensen distinguished *A. iranica* from *A. cepheus* (Müller and Troschel, 1842) by 5–6 spines on each oral plate in the former and two spines on of each oral plate in the latter[12]. Species *A. cepheus* is distinguished from *A. iranica* by the form of spinelets and spines and the number of inter-radial spines per plate[11].

Discussion

One of the most diverse groups within the phylum Echinodermata is the class Asteroidea, that includes approximately 1900 extant species[13]. These species are most diverse in the tropical Indo-Pacific regions[14,15]. Representatives of Asterinidae seastars inhabit the world shallow waters, and are widely distributed in the Indo-Pacific to a depth of about 20 m[14]. Clark and Rowe reported 26 asterinid species from the Indo-West Pacific shallow waters[15].

In the present study, *Patiriella paradoxa* was found for the first time from the rocky subtidal of Konarak located in the eastern part of Chabahar Bay in the north-east of the Gulf of Oman to a depth of 7 m. Predominantly, *Patiriella* species are distributed in temperate waters in the inter-tidal zone and to a depth of about 30 m[7]. *Patiriella regularis* and *P. mortenseni* are endemic New Zealand species[8]. *Patiriella oliveri* is distributed in New Zealand and Australia[16]. Campbell and Rowe extended the distribution of genus *Patiriella* to the north-west Indian Ocean with their description of *Patiriella paradoxa* from Dhofar in tropical southern Oman[7]. We extend this distribution to southern Iran.

Three species in the genus *Aquilonastra* have previously been reported from the Iranian coast as: *Asterina iranica* (by Mortensen[12], subsequently referred to *Aquilonastra* by O'Loughlin and Rowe[11]); *Asterina burtoni* (by Clark and Rowe; Price, subsequently referred to Aquilonastra by O'Loughlin and Rowe)[11,15,17,18,19]; and *A. samyni* O'Loughlin and Rowe 2006 (by Pourvali)[20]. *Aquilonastra watersi* has previously been reported from the Western Indian Ocean in the Arabian Sea, the Red Sea, Mauritius, on rocks, algae, coral rubble and littoral reef substrate[11]. The species *A. iranica* has been reported from Persian Gulf, the West of Pakistan on soft and hard substrate[11,12]. In this research, *A. watersi* and *A. iranica* were found for the first time from the sandy-rocky inter-tidal zone of the Tis Port located in the West of Chabahar Bay and north-east of the Oman Gulf.

To date, five species of seastars have been recorded from Chabahar Bay in the Gulf of Oman on the Iranian coast by Khaleghi[1] and Esfandyarpoor[21]: *Asteropecten hemprichi* (Müller and Troschel 1842), *Astropecten polyacanthus polyacanthus* (Müller and Troschel 1842), *Astropecten polyacanthus phragmorus* (Fisher, 1913), *Asteropecten indicus* (Doderlein, 1889), *Luidia hardwicki* (Gray, 1840). In the present study, three additional asteroid species are reported: *P. paradoxa*, *A. watersi* and *A. iranica*.

We report for the first time the live colour of species *Patiriella paradoxa*: dark green becoming black on disc and upper rays. We report live colour differences for our specimens of *Aquilonastra watersi* (abactinal surface proximal rays and inter-radii mottled with dark and light red and white, disc and upper rays mottled red) to the colours reported by O'Loughlin and Rowe[11] (mottled pale brown, red-brown, gray-brown, blue-gray, off-white). Our live specimen colours for *Aquilonastra iranica* agree with

the descriptions by Mortensen (grayish with reddish or bluish-gray spots) [12].

We observed a consistence of intra-specific morphological characters for the three species in this study, except for some variations in spine and spinelet number per plate. In the case of *Aquilonastra iranica*, we noted a significant difference in actinal spines per plate in our observed specimens and the description by O'Loughlin and Rowe[11].

During this study, in the specimens *Aquilonastra iranica* with size difference, we observed variable spine and spinelet number. Therefore, this is a variation character.

Conclusion

The Asteroidea are the second most diverse group within Echinodermata phylum[13]. In the present study, species of *Patiriella paradoxa* (Campbell and Rowe 1997), *Aquilonastra watersi* (O'Loughlin and Rowe 2006) and *Aquilonastra iranica* (Mortensen, 1940) are reported as new records from Chabahar Bay (Oman Gulf) in the sub-tidal and inter-tidal zones.

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References

1 Khaleghi, M., *Echinoderms species of Chabahar Bay*. MSc thesis, University of Khoramshahr, Iran, (2010) 80 pp.

2 Khleghi, M. and Owfi, F., Identification of Echinoidea species in the intertidal zones of Chabahar Bay. *J Anim Environ*.,4 (2011) 31-36.

3 Khleghi, M., Identification of Holothurians Species (Holothuroidea: Echinodermata) in the Intertidal Zones of Chabahar Bay. *J Anim Environ*., 2(2013) 61-69.

4 Attaran–Fariman, G., Beygmoradi, A. and Boos, K., First record of *Ophionereis dubia* (Echinodermata: Ophiuroidea) from Chabahar Bay (Gulf of Oman, Iran). *Mar Bio Re*.,7(e92) (2014) 1-5.

5 Pourvali, N., Esfandiarpour, F., Shakouri, A. and Rezai, H., Seastar (Echinodermata) species diversity and distribution in the southeast of Iran (Gulf of Oman). *J Bio Environ Sci*., 5(2014) 14-20.

6 Dartnall, A.J., Australian seastars of the genus *Patiriella* (Asteroidea, Asterinidae). *ProcLinn Soc N. S. W*., 96(1971) 39-51.

7 Campbell, A.C and Rowe, F.W.E., A new species in the asterinid genus *Patiriella* (Echinodermata: Asteroidea) from Dhofar, southern Oman: a temperate taxon in a tropical locality. *Bull Nat Hist Mus Zool Ser*., 63(1997) 129-136.

8 O'Loughlin, P.M., Waters, J.M. and Roy, M.S.m Description of a new species of *Patiriella* from New Zealand, and review of *Patiriella regularis* (Echinodermata: Asteroidea) based on morphological and molecular data. *J Royal Soc New Zealand*., 32 (2002) 697-711.

9 O'Loughlin, P.M., Waters, J.M. and Roy, M.S., A molecular and morphological review of the asterinid, *Patiriella gunnii* (Gray) (Echinodermata: Asteroidea). *Mem Mus Vic*., 60(2) (2003) 181-195.

10 O'Loughlin, P.M. and Waters, J.M., A molecular and morphological revision of genera of Asterinidae (Echinodermata: Asteroidea). *Mem Mus Vic*., 61(1) (2004) 1-40.

11 O Loughlin, P.M. and Rowe, F.W.E., A systematic revision of the asterinid genus *Aquilonastra* O Loughlin, 2004 (Echinodermata: Asteroidea). *Mem Mus Vic*., 63(2) (2006) 257-287.

12 Mortensen, T.H., *Echinoderms from the Iranian Gulf*. Danish Scientific Investigations in Iran2: 55-112, pls 1, 2. EjnarMunksgaard: Copenhagen, (1940).

13 Mah, C.L. and Blake, D.B., Global diversity and phylogeny of the Asteroidea (Echinodermata). *PLoS One*., 7(2012) e35644.

14 Blake, D.B., Adaptive zones of the class Asteroidea (Echinodermata). *Bull Mar Sci*., 46(3) (1990) 701-718.

15 Clark, A. and Rowe, F., *Monograph of shallow water Indo-West pacific Echinoderms*. London: Trustees of the British Museum (Natural History), (1971).

16 McKnight, D.G., Some echinoderms from the Kermadec Islands, New Zealand.*J Mar Fresh Res*., 2 (3) (1968) 505-526.

17 Price, A.R.G., Studies on the echinoderm fauna of the western Gulf. *J Nat His*., 15(1981) 1-15.

18 Price, A.R.G., Echinoderm of Saudi Arabia. Comparison between Echinoderm faunas of Persian Gulf, SE Arabia, Red Sea, Gulfs of Aqaba and Suez. *Fau Saudi Arabia*, 4(1982) 3-21.

19 Price, A.R.G., Echinoderms of Saudi Arabia. Echinoderm of the Gulf Coast of Saudi Arabia. *Fau Saudi Arabia*, 5(1983) 28-108.

20 Pourvali, N., New Report of Sea Star, *Aquilonastra samyni* (Echinodermata: Asteroidea), from the Strait of Hormuz, the Persian Gulf. *World J Zool*., 8(4) (2013) 415-416.

21 Esfandyarpoor, F., *Study on Distribution of Starfish in the Intertidal Zone of Chabahar Bay*. MSc thesis, Chabahar Maritime University, Iran, (2014), 84 pp.